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ABSTRACT

This document describes Montana's postsecondary curriculum to prepare hazardous materials technicians. Basic general education requirements are described. The technical skills and the knowledge associated with each are listed in the following categories: (1) site assessment; (2) sampling materials; (3) handling materials; (4) recording data; (5) laboratory skills; and (6) safety. The certification that should be available to course completers includes that for 40-hour hazardous waste site, 24-hour hazardous materials update, 8-hour emergency first responder awareness level, monitoring well driller/constructor certification (state requirement), and asbestos accreditation. The state and federal laws, rules, and regulations with which the Montana hazardous materials technician must be most familiar are listed. An equipment list for the course and a five-item bibliography also appear. (CML)

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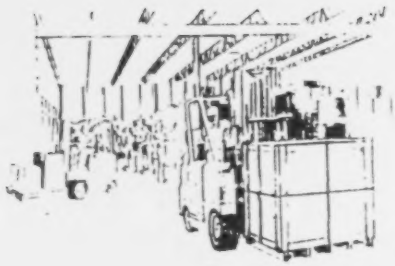

# HAZARDOUS MATERIALS TECHNICIAN

Technical Committee
on Occupational
Curriculum Development

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# HAZARDOUS MATERIALS TECHNICIAN

# TECHNICAL ADVISORY COMMITTEE

# ON CURRICULUM DEVELOPMENT

Montana Center for Vocational Education
Research, Curriculum and Personnel Development
Located at Northern Montana College
P. O. Box 7751
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JUNE, 1990

TABLE OF CONTENT


Foreword . . . . . i

Committee Members . . . . . ii

Acknowledgements . . . . . iv

Rationale and Projected Needs . . . . . 1

Hazardous Materials Technician Curriculum . . . . . 5

Introduction . . . . . 5

Basic General Academic Requirements . . . . . 5

Technical Skills and Knowledges . . . . . 6

A. Site Assessment . . . . . 6

B. Sampling Materials . . . . . 10

C. Handling Materials . . . . . 16

D. Record Data . . . . . 22

E. Laboratory Skills . . . . . 23

F. Safety . . . . . 27

Certification . . . . . 35

Laws, Rules and Regulations . . . . . 36

Equipment List . . . . . 39

Bibliography . . . . . 40

## FOREWORD

The Carl D. Perkins Vocational Education Act (Public Law 98-524) was enacted in 1984 to replace the Vocational Education Act of 1963 and its subsequent amendments. It is the major vehicle for federal support of vocational education to the states. In an effort to better target the responsiveness of vocational and technical education and training to the requirements of the marketplace, the Act mandates greater involvement of business and industry in the curriculum development process through the mechanism of State Technical Committees.

In 1988, the Montana Office of the Commissioner of Higher Education, with the assistance of the State Council for Vocational Education designated 14 distinct business and industry areas for future Technical Committee organization. Five Technical Committees were established for 1988-89 to assist in the development of model curricula and to address state labor market needs.

The designated committees were Tourism and Travel, Agriculture, Forestry and Lumber, Health Care, and Mining and Minerals. The Center for Vocational Education facilitated the process as they developed an inventory of skills and knowledges applicable to state-of-the-art curriculum. Each committee was made up of practitioners in the field, including employers, employees, organized labor, professional organizations and state agencies.

In 1990, two additional committees were designated, i.e., Hazardous Materials Technician and Eldercare Aide. Again the membership of the committees was made up of practitioners in the field who had first hand knowledge of the supply and demand of the skills and knowledges required of workers in the field.

The Montana Center for Vocational Education facilitated the committees' activities and provided the necessary research to assist in the development of the materials. This report summarizes the Hazardous Materials Technician Committee's suggestions and recommendations. It should provide assistance in determine the needs for a training program and provide direction in developing appropriate curriculum.

The Center is grateful to all those who participated in the project, especially Ginger Faber who was responsible for coordinating the activities.

A. W. "Gus" Korb, Director
Center for Vocational Education
Research, Curriculum and Personnel
Development
June, 1990

MONTANA HAZARDOUS MATERIALS TECHNICAL COMMITTEE
1990

In identifying committee members, an effort was made to cover the major fields involved in hazardous materials waste problem areas including fire, mining and minerals, water quality, health, environment, asbestos removal, transportation and disposal, air toxics, emergency first responder, and general management.

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## RATIONALE AND PROJECTED NEEDS

At hazardous waste sites across the United States, toxic chemicals are contaminating the land, air and groundwater supplies. In the 1970's, the nation was largely unaware that there was a hazardous waste problem. To those concerned with hazardous waste in the mid-seventies, the main problem seemed to be the management of trash and the need for recycling of materials. In the late seventies the careless disposal practices of the past began to turn places like the Love Canal in New York State into images of environmental calamity.

About that time it became evident legislation was needed to control hazardous waste disposal required by the RCRA (Resource Conservation and Recovery Act passed in 1976). No one knew where the hazardous waste generators were, what was in their waste streams, how much there was of it, or where it was going.

As recently as the end of World War II, the United States produced only one billion pounds of hazardous wastes per year. The rate of production of such waste has since increased at a rate of about ten percent per year. "The Environmental Protection Agency (EPA) now estimates that about 80 billion pounds of hazardous waste material are generated annually - about 350 pounds of hazardous waste for every inhabitant of the United States" (Epstein, Brown & Pope, 1982, p 7). A wide variety of industries produce these wastes.

In order to provide for cleanup at sites where hazardous wastes had been abandoned or where past hazardous waste disposal practices had contaminated the environment, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) was enacted in 1980. CERCLA filled the gap in the national system to protect public health and the environment from hazardous substances by authorizing federal action. Projected "Superfund" expenditures are expected to be in the billions of dollars.

According to Mr. Robert L. Fox of the Environmental Protection Agency Superfund Branch office in Helena, Montana, approximately $26,000,000 was spent by the EPA in Montana from 1983-1989. In Fiscal Year 1990, projected expenditures will be approximately $5,000,000 and an additional amount of $6,500,000 in Fiscal Year 1991. Projected work to be implemented by Potentially Responsible Parties (PRPs) may total $15,000,000 - $20,000,000 in Fiscal Year 1990 and at least $15,000,000 - $20,000,000 in Fiscal Year 1991. While these figures include expenditures for all areas of hazardous waste cleanup, included are employment needs covering all phases and levels of operations.

Although employment statistics regarding hazardous waste cleanup are scarce, it is essential to remember that solving the hazardous waste problem is an immense physical undertaking. There are literally mountains to be moved. Proper disposal of hazardous wastes entail complex disposal methods and are potentially dangerous if not managed correctly. Employment may range from environmental engineers over-seeing operations to individuals operating trucks and specialized equipment.

Specific job projections for Hazardous Materials Technicians in Montana are difficult to define as out-of-state contractors working in Montana may be hiring employees from both in-state as well as out-of-state. Based on the number of employees currently working in the field of hazardous waste in Montana, the Hazardous Materials Technical Committee members projected the future employment needs by using the analyses in the following paragraphs. It was the consensus of the group that at least 200 - 375 trained Hazardous Materials Technicians would be gainfully employed in Montana in the next few years.

Hazardous wastes are commomly classified in the following major categories: radioactives; flammables; heavy metals; asbestos; acids and bases; and synthetic organic chemicals.

Radioactives, collectively known as "radionuclides", are elements that are intrinsically unstable, giving off energy or charged particles as they decay. They have the potential to damage living tissue and are highly dangerous. They can cause immediate death, burns or injury, and even small quantities lead to birth defects, cancer, and other chronic disease. Hazardous Materials Technicians working with radioactives in Montana include individuals monitoring Radon, and those transporting hazardous materials through Montana. Consequently, it was estimated that ten consultants working in the field of Radon would be required. Obviously those transporting radioactives through the state would not be Montana employees.

Flammables consist of a category of chemicals which are dangerous because of their tendency to react strongly with other materials. The most important flammables are petroleum or natural gas by-products. Their reactivity makes their hazard short-lived as, once they are released into the environment, they immediately come into contact with atmospheric oxygen and heat or sparks. In Montana the problem centers around the cleaning up of petroleum spills, and the removal and replacement of underground storage tanks.

Since approximately 25% of the existing gas stations in Montana will need new storage tanks and/or will have to clean-up old leaks, many trained individuals will be required to complete this work. The Montana Trust Fund, which was established to assist in this type of clean-up, will pay for these clean-up activities if the expense exceeds $17,500. (The funding for the Trust Fund is taken

from an already established gas tax). The station owner is then required to pay for new installations. Hazardous Materials Technicians trained at the two-year level may be hired for monitoring and sampling of materials in this regard. An estimated 50 to 60 workers, operators, or technicians will be required to do sampling, defining, and work around clean-up sites.

While mining was the first significant source of hazardous wastes, heavy metals were, for many centuries, the major component of hazardous wastes. Among the most important is lead, arsenic, zinc, cadmium, copper, and mercury which were among the first raw materials to be used for technological purposes. Modern industry also makes use of other heavy metals such as selenium, beryllium, and cadmium.

Overall rates of utilization of most heavy metals has continued to increase dramatically in the past century and will continue to do so. Even as old uses of heavy metals are phased out, new uses continue to increase our dependence on them. Many abandoned mines and reclamation projects in Montana are in need of clean-up attention. Poor practices in mining have left heavy metals in mining tailings and sites such as the Clark Fork clean-up project. These activities will engage as many as 50 - 100 Hazardous Materials Technicians in the next few years.

Asbestos is the generic name for a group of minerals composed of calcium or magnesium silicates formed into long, threadlike fibers. The fibrous nature of asbestos and its resistance to biological degradation and chemical change is what makes it so dangerous. Easily penetrating the exposed surfaces of the lungs, tiny fibers and fibrils continuously irritate resulting in a lung disease known as asbestosis or a variety of cancers of the lung or other sites when blood carries the fibers through the body.

Recent laws regarding removal of asbestos in schools and public buildings has created a need for technicians in Montana to perform evaluations, removal and disposal of asbestos. As a result, an estimate of approximately 80 workers in the area of inspection and removal will be required.

Materials that are very acidic or basic are extremely reactive and corrosive, but their hazards are relatively short-lived. Once released into the environment, acids encounter bases and vice versa. The acids then leave behind salts and water. In large concentrations, acids and bases can do considerable damage along the way, especially if released into small streams. Additionally, acids may dissolve heavy metals out of soils or sediment, and these heavy metals remain in suspension even after the acid has been neutralized.

Pertinent to Montana regarding acids and bases are concerns reflected in the mining industry in monitoring of the leaching process and water contamination. Approximately 50 - 60 technicians would be required in this area.

While heavy metals, asbestos, acids, and bases have been used for hundreds of years, synthetic organic chemicals are a relatively new category of industrial product. Whether manufactured or synthesized from coal, natural gas, or petroleum, synthetic organic chemicals are a diverse group with a wide range of uses. Most evident since the advent of the petrochemical era, products derived from these chemicals have increasingly supplanted natural materials such as cotton, wood, leather, and natural rubber. While there are many advantages in their use, these advantages have occurred at the expense of the health of exposed workers and of the general public, as well as the generation and disposal of highly hazardous toxic wastes. Herbicides and pesticides used in Montana in the area of weed control would require 50 - 60 technicians or at least one per county.

The problem of cleaning up the hazardous waste sites in America requires a coordinated effort of Federal, State and local governments, private industry, and citizens. The problems are widespread and often will require time and a great deal of effort to resolve, as this is one of the major environmental challenges of the decade.

# HAZARDOUS MATERIALS TECHNICIAN CURRICULUM

## Introduction

Based on the projected needs and apparent state and national concerns for better waste management, it was the consensus of the Technical Committee that there will be a growing need for a "Hazardous Materials Technician" to work with the professional engineers, hydrologists and scientists to solve the environmental problems. The job title is currently nonexistent but is emerging rather quickly as the industry and government deal with the environmental issues.

Consequently, a training program was identified which could be implemented into a postsecondary school leading to an associate degree. The program would consist of basic "general education" core requirements and specific technical skills and knowledges. The following describes the program in some detail.

## Basic General Academic Requirements

A Hazardous Materials Technician should have general academic and basic skills. This individual's math and science skills should be equal to those taught in a typical two-semester college organic and inorganic chemistry sequence and a college statistics course. Basic computer skills are also essential.

The appropriately trained technician should be computer literate capable of manipulating software and analyzing data using typical equipment. The technical training program should acquaint the technician with several software documents peculiar to the industry including computer spread sheets and data manipulation.

Communication skills should entail English, speech and technical writing courses which would enable the Hazardous Materials Technician to communicate detailed information pertaining to specific job requirements. Additional skills in business, record keeping and office equipment, including calculator operations, might prove beneficial in working as a Hazardous Materials Technician.

The Hazardous Materials Technician must be able to read plans, and specifications and know how to interpret contracts, clauses, and conditions. Elective courses might include first aid, CPR, emergency responder training courses, geology/soils, law, and knowledge of labor laws and regulations such as workers compensation, social security, etc. Site practicum or cooperative education requirements would be a highly desirable part of this curriculum.

## Technical Skills and Knowledges

**A - SITE ASSESSMENT**

The Hazardous Materials Technician will be capable of the following "site assessment and control" tasks regarding radioactives, flammables, heavy metals, asbestos, acids and bases, and synthetic organic chemicals. Each task may be performed differently depending upon the type of materials present.

**Tasks:**

A-1 Activate response plan (chain of command; who is in control)
A-2 Implement site safety plan
A-3 Establish boundaries (size)
A-4 Determine site topography and accessibility
A-5 Check for immediate dangers to life and health
A-6 Determine needs for protective clothing
A-7 Record findings
A-8 Report findings to appropriate authorities or employers
A-9 Control, monitor, and close site

The following knowledges should be taught or reviewed concurrently when teaching the above site assessment skills.

**Knowledges:**

1-A how hazardous materials incidents are different from other emergencies;

2-A the general routes in which hazardous materials enter the human body upon exposure;

3-A the limitations of street clothes or work clothes at the scene of a hazardous materials incident;

4-A the threats posed to property and the environment by hazardous materials releases;

5-A necessary precautions to take when rendering emergency medical care to victims of hazardous materials exposure;

6-A typical ignition sources found at the scene of a hazardous materials incident;

7-A the basic techniques used to deny site entry;

8-A the basic techniques used to isolate the immediate site;

9-A the basic techniques for evacuation in a hazardous materials incident;

10-A the functions and responsibilities of the hazard sector personnel within the Incident Command System.

Functions include:

(a) safety
(b) entry/reconnaissance
(c) information/research
(d) resources
(e) decontamination
(f) operations

11-A placards, labels, container markings, and shipping papers used in the transportation of hazardous materials;

12-A the risk assessment considerations to be made at a hazardous materials incident including:

(a) size and type of container and quantity involved
(b) nature of the container stress
(c) potential behavior of the container and its contents
(d) level of resources available (e.g., personal protective equipment, training, etc.)
(e) exposure potential to people, property, environment, and systems
(f) weather conditions and terrain

13-A the various types of monitoring equipment used to monitor and detect the following hazards:

(a) toxicity
(b) flammability
(c) reactivity
(d) radioactivity
(e) corrosivity
(f) oxygen deficiency

14-A how to use a MSDS in obtaining hazard and response information to determine isolation and evacuation distances;

15-A the following chemical and physical terms, and their use in the risk assessment process:

(a) air reactivity
(b) catalysts and inhibitors
(c) concentration
(d) corrosivity
(e) critical temperature and pressure
(f) instability
(g) oxidation ability
(h) ph
(i) polymerization
(j) radioactivity
(k) self-accelerating decomposition temperature (SADT)
(l) strength
(m) sublimation
(n) surface tension
(o) viscosity
(p) volatility
(q) water reactivity

16-A the following toxicological terms and their use in the risk temperature process:

(a) threshold limit value (TLV-TWA)
(b) lethal concentration and doses (LD 50/100)
(c) parts per million/billion (ppm/ppb)
(d) immediately dangerous to life and health (IDLH)
(e) permissible exposure limit (PEL)
(f) short-term exposure limit (TLV-STEL)
(g) ceiling level (TLV-C)

17-A the following toxicological terms and their importance in the risk assessment process:

(a) chemical interactions
(b) dose-response relationship
(c) effects: local, systemic
(d) exposure: acute, subacute, chronic
(e) routes of entry: ingestion, absorption, inhalation

18-A the following radiological terms:

(a) half-life
(b) time, distance, shielding

19-A the respiratory hazards encountered at a hazardous materials incident, and the need for proper protective breathing apparatus as prescribed by OSHA;

20-A the limitations of personnel working with protective breathing apparatus;

21-A the application, use and limitations of the following levels of protective clothing used at a hazardous materials cite:

(a) structural fire fighting clothing
(b) chemical fire protective clothing (encapsulating and nonencapsulating)
(c) high temperature clothing

22-A the proper donning, doffing, and usage of all personal protective equipment provided by the authority having jurisdiction for use in normal response activities;

23-A the factors to be considered in selecting proper respiratory protection at a hazardous materials incident;

24-A the three types of Level A chemical protective clothing and the advantages and disadvantages of each type. Reference: Type 1, SCBA worn inside the suit; Type 2, SCBA worn outside the suit; and Type 3, breathing air supplied by air line.)

25-A the basic design and construction of containers, and bulk and nonbulk packaging used to store, process, or transport hazardous materials, which would include but not be limited to:

(a) bags
(b) bottles
(c) boxes
(d) cans
(e) carboys
(f) drums
(g) fixed tanks
(h) intermodal portable tanks
(i) piping
(j) tank cars
(k) tank trucks and trailers

26-A the basic decontamination procedures, as defined by the authority having jurisdiction, for victims, personnel, personal protective equipment, tools, equipment, and apparatus at a hazardous materials incident;

27-A the advantages and limitations of each of the following methods of decontamination:

(a) absorption
(b) adsorption
(c) chemical degradation
(d) dilution
(e) disposal
(f) isolation
(g) neutralization
(h) solidification

28-A the considerations associated with the placement, location, and set up of a decontamination site;

29-A the importance of documentation of a hazardous materials incident including training records, exposure records, incident and critique reports;

30-A how to keep an activity log and exposure records for a hazardous materials incident;

31-A which activities are required in terminating the emergency phase of a hazardous materials incident;

32-A the preparation of a locally required report with the supporting documentation as necessary;

**B - SAMPLING MATERIALS**

The Hazardous Materials Technician will be capable of the following "sampling" tasks with regard to radioactives, flammables, heavy metals, asbestos, acids and bases, and synthetic organic chemicals. Each sampling procedure may be done differently depending upon the type of material.

**Tasks:**

B-1 Calibrate equipment
B-2 Maintain equipment
B-3 Operate equipment

B-4 Use standard operating procedures for sampling appropriate mediums
B-5 Maintain quality assurance, quality control (chain of custody, tracking)
B-6 Interpret analytical data
B-7 Record results

The following knowledges should be taught or reviewed concurrently when teaching the above sampling skills.

**Knowledges:**

1-B how hazardous materials incidents are different from other "general" emergencies;

2-B the general routes in which hazardous materials enter the human body upon exposure;

3-B the limitations of street clothes or work clothes at the scene of a hazardous materials incident;

4-B the threats posed to property and the environment by hazardous materials incident;

5-B the precautions necessary when rendering emergency medical care to victims of hazardous materials concerns;

6-B the components of a site safety plan for a hazardous materials incident;

7-B the process for implementing the Incident Command System for hazardous materials emergencies;

8-B the functions and responsibilities of the hazard sector personnel within the Incident Command System.

Functions include:

(a) safety
(b) entry/reconnaissance
(c) information/research
(d) resources
(e) decontamination
(f) operations

9-B the nine hazardous materials classes, and the primary hazards of each class;

10-B how to use the six groups of clues to detect the presence of hazardous materials;

11-B the placards, labels, container markings, and shipping papers used in the transportation of hazardous materials, their advantages, disadvantages, and limitations in recognizing hazardous materials;

12-B the shipping papers found in various modes of transportation, the individual's responsible for the papers, and location where carried and found during an incident;

13-B the risk assessment considerations to be made at a hazardous materials incident including:

(a) size and type of container and quantity involved
(b) nature of the container stress
(c) potential behavior of the container and content
(d) level of resources available (e.g. personal protective equipment, training, etc.)
(e) exposure potential to people, property, environment, and systems
(f) weather conditions and terrain

14-B the various monitoring equipment used to monitor and detect the following hazards:

(a) toxicity
(b) flammability
(c) reactivity
(d) radioactivity
(e) corrosivity
(f) oxygen deficiency

15-B the purpose, operation (including interpretation of results and operation and calibration checks), and limitations for the following basic monitoring equipment in addition to any other monitoring equipment provided to the hazardous waste technician by the authority having jurisdiction:

(a) combustible gas detector
(b) oxygen meter
(c) colorimetric tubes
(d) ph papers and strips
(e) CO meter
(f) radiation detection instruments
(g) OVA (Organic Vapor Analyzer)
(h) HNU (Photoionization Analyzer)
(i) explosimeter

16-B field maintenance and testing procedures, including operational and calibration checks, for the basic monitoring equipment provided to the hazardous materials technician by the authority having jurisdiction;

17-B how to use the DOT Emergency Response Guidebook (ERG) in assessing hazards and response actions, and determining isolation and evacuation distances;

18-B know how to use a MSDS in obtaining hazard and response information and how to determine isolation and evacuation distances;

19-B the source of, definition of, and circumstances for use of the following terms:

(a) hazardous substances
(b) hazardous chemicals
(c) extremely hazardous substances
(d) hazardous wastes
(e) hazardous materials
(f) dangerous goods

20-B the advantages and disadvantages of each of the following information sources:

(a) MSDS
(b) reference guidebooks
(c) hazardous materials data bases
(d) technical information centers (CHEMTREC, National Response Center)
(e) technical information specialists
(f) monitoring equipment
(g) NIOSH pocket guide to chemical hazards

21-B the analysis procedure for identification of unknown hazardous materials;

22-B the following chemical and physical properties and their importance in the risk management process:

(a) boiling point
(b) flammable (explosive) limits
(c) flash point
(d) ignition (autoignition) temperature
(e) specific gravity
(f) vapor intensity

(g) vapor pressure
(h) water solubility

23-B the following:

(a) Alpha Radiation
(b) Beta Radiation
(c) Gamma Radiation

24-B the following chemical and physical terms and their use in the risk assessment process:

(a) air reactivity
(b) catalysts and inhibitors
(c) concentration
(d) corrosivity
(e) critical temperature and pressure
(f) instability
(g) oxidation ability
(h) ph
(i) polymerization
(j) radioactivity
(k) self-accelerating decomposition temperature (SADT)
(l) strength
(m) sublimation
(n) surface tension
(o) viscosity
(p) volatility
(q) water reactivity

25-B the following toxicological terms and their use in the risk temperature process:

(a) threshold limit value (TLV-TWA)
(b) lethal concentration and doses (LD 50/100)
(c) parts per million/billion (ppm/ppb)
(d) immediately dangerous to life and health (IDLH)
(e) permissible exposure limit (PEL)
(f) short-term exposure limit (TLV-STEL)
(g) ceiling level (TLV-C)

26-B the respiratory hazards encountered at a hazardous materials incident, and the need for proper protective breathing apparatus, as prescribed by OSHA;

27-B the limitations of personnel working with protective breathing apparatus;

28-B the types of protective breathing apparatus and the advantages and limitations of each at a hazardous materials incident;

29-B the application, use and limitations of the following levels of protective clothing used at a hazardous materials incident:

(a) structural fire fighting clothing
(b) chemical fire protective clothing (encapsulating and nonencapsulating)
(c) high temperature clothing

30-B the proper donning, doffing, and usage of all personal protective equipment provided by the authority having jurisdiction for use in normal response activities;

31-B the following terms as associated with chemical protective clothing:

(a) degradation
(b) penetration
(c) permeation

32-B how to interpret a chemical compatibility chart for chemical protective clothing, and the limitations and deficiencies of compatibility charts;

33-B the four levels of protection as found in the EPA/OSHA publications, the equipment required for each level, and the conditions under which each level is used;

34-B at least four conditions that indicate material degradation of chemical protective clothing after chemical contact;

35-B the tools, maintenance, and testing procedures for the tools, equipment, and materials provided to the hazardous materials technician by the authority having jurisdiction for the control of the hazardous materials releases;

## C - HANDLING MATERIALS

The Hazardous Materials Technician will be capable of the following "handling" tasks regarding radioactives, flammables, heavy metals, asbestos, acids and bases, and synthetic organic chemicals. Each task may be performed differently depending upon the type of material present.

**Tasks:**

C-1 Handling samples
C-2 Handling drums and containers
C-3 Manifesting containers
C-4 Packaging of materials
C-5 Removing, transporting, and disposing of material
C-6 Record data

The following knowledges should be taught or reviewed concurrently when teaching the above skills in handling materials.

**Knowledges:**

1-C how hazardous materials incidents are different from other general emergencies;

2-C ways hazardous materials incidents are harmful to people at a hazardous materials incident;

3-C the general routes in which materials enter the human body upon exposure;

4-C the limitations of street clothes or work clothes at the scene of a hazardous materials incident;

5-C the threats posed to property and the environment by hazardous materials releases;

6-C the functions and responsibilities of the hazard sector personnel within the Incident Command System;

7-C the nine hazardous materials classes, and the primary hazards of each class;

8-C how to use the six groups of clues to detect the presence of hazardous materials;

9-C the typical locations in the community of facility where hazardous materials are manufactured, transported, stored, used, or disposed of;

10-C the placards, labels, container markings, and shipping papers used in the transportation of hazardous materials, and their advantages and limitations in recognizing hazardous materials;

11-C the shipping papers found in various modes of transportation, the individuals responsible for the papers, and location where carried and found during the incident;

12-C various containers and packages, and the materials that may typically be found in them.

13-C the risk assessment consideration to be made at a hazardous materials incident including:

(a) size and type of container and quantity involved
(b) nature of the container stress
(c) potential behavior of the container and its contents
(d) level of resources available (e.g. personal protective equipment, training, etc.)
(e) exposure potential to people, property, environment, and systems
(f) weather conditions and terrain

14-C monitoring equipment used to monitor and detect the following hazards:

(a) toxicity
(b) flammability
(c) reactivity
(d) radioactivity
(e) corrosivity
(f) oxygen deficiency

15-C the purpose, operation (including interpretation of results and operation and calibration checks), and limitations for the following basic monitoring equipment, in addition to any other monitoring equipment provided to the hazardous materials technician by the authority having jurisdiction:

(a) combustible gas detector
(b) oxygen meter
(c) colorimetric tube
(d) ph papers and strips
(e) CO meter
(f) radiation detection instruments
(g) OVA (Organic Vapor Analyzer)
(h) HNU (Photoionization Analyzer)
(i) explosimeter

16-C field maintenance and testing procedures, including operational and calibration checks, for the basic monitoring equipment provided to hazardous materials technicians by the authority having jurisdiction;

17-C the specific names of hazardous material involved in an emergency, or at least how to classify the material by its primary hazard using container markings, placards, pesticide labeling, shipping papers, Material Safety Date Sheets (MSDS), or personal contacts;

18-C how to use a MSDS in obtaining hazard and response information and how to determine isolation and evacuation distances;

19-C the source of, definition, and circumstances for the use of the following terms:

(a) hazardous substances
(b) hazardous chemicals
(c) extremely hazardous substances
(d) hazardous wastes
(e) hazardous materials
(f) dangerous goods

20-C the advantages and disadvantages of each of the following information sources:

(a) MSDS
(b) reference guidebooks
(c) hazardous materials data bases

(d) technical information centers (CHEMTRES, National Response Center)
(e) technical information specialists
(f) monitoring equipment
(g) NIOSH pocket guide to chemical hazards

21-C the analysis procedure for identification of unknown hazardous materials;

22-C the following chemical and physical properties and their importance in the risk assessment process:

(a) boiling point
(b) flammable (explosive) limits
(c) flash point
(d) ignition (autoignition) temperature
(e) specific gravity
(f) vapor density
(g) vapor pressure
(h) water solubility

23-C the following:

(a) Alpha Radiation
(b) Beta Radiation
(c) Gamma Radiation

24-C the following chemical and physical terms and their use in the risk assessment process:

(a) air reactivity
(b) catalysts and inhibitors
(c) concentration
(d) corrosivity
(e) critical temperature and pressure
(f) instability
(g) oxidation ability
(h) ph
(i) polymerization
(j) radioactivity
(k) self-accelerating decomposition temperature (SADT)
(l) strength
(m) sublimation
(n) surface tension
(o) viscosity
(p) volatility
(q) water reactivity

25-C the following toxicological terms and their use in the risk temperature process:

(a) threshold limit value (TLV-TWA)
(b) lethal concentration and doses
(c) parts per million/billion (ppm/ppb)
(d) immediately dangerous to life and health (IDLH)
(e) permissible exposure limit (PEL)
(f) short-term exposure limit (TLV-STEL)
(g) ceiling level (TLV-C)

26-C the respiratory hazards encountered at a hazardous materials incident, and the need for proper protective breathing apparatus, as prescribed by OSHA;

27-C the limitations of personnel working with protective breathing apparatus;

28-C the types of protective breathing apparatus and the advantages and limitations of each at a hazardous materials incident;

29-C the procedure for cleaning and sanitizing protective breathing apparatus for future use;

30-C the operational components of the types of protective breathing apparatus provided by the authority having jurisdiction and their functions;

31-C the application, use and limitations of the following levels of protective clothing used at a hazardous materials incident:

(a) structural fire fighting clothing
(b) chemical fire protective clothing (encapsulating and nonencapsulating)
(c) high temperature clothing

32-C the proper donning, doffing, and usage of all personal protective equipment provided by the authority having jurisdiction for use in normal response activities;

33-C the factors to be considered in selecting proper respiratory protection at a hazardous materials incident;

34-C how to select the appropriate personal protective equipment to be used in an incident;

35-C the following terms as associated with chemical protective clothing:

(a) degradation
(b) penetration
(c) permeation

36-C how to interpret a chemical compatibility chart for chemical protective clothing, and the limitations and deficiencies of compatibility charts;

37-C maintenance, inspection, and storage procedures for level B and C chemical protective equipment provided by the authority having jurisdiction;

38-C the four levels of protection as found in the EPA/OSHA publications, the equipment required for each level, and the conditions under which each level is used;

39-C the conditions that indicate material degradation of chemical protective clothing after chemical contact;

40-C the three types of level A chemical protective clothing and the advantages and disadvantages of each type. (Reference: Type 1, SCBA worn inside the suit; Type 2, SCBA worn outside the suit; and Type 3, breathing air supplied by air line).

41-C the three methods of cooling level A chemical protective clothing and the advantages and disadvantages of each method;

42-C the physical and psychological stresses that can affect users of specialized protective clothing;

## D - RECORD DATA

The Hazardous Materials Technician will be capable of the following "recording" tasks regarding radioactives, flammables, heavy metals, asbestos, acids and bases, and synthetic organic chemicals. Each task may be performed differently depending upon the type of material present.

**Tasks**:

D-1 Maintain field sheets
D-2 Enter data into computer
D-3 Analyze data
D-4 Manipulate data
D-5 Maintain equipment history
D-6 Assimilate historical data
D-7 Retrieve information from references

The following knowledges should be taught or reviewed concurrently when teaching the above skills in recording data.

**Knowledges**:

1-D the advantages and disadvantages of each of the following information sources:

(a) MSDS
(b) reference guidebooks
(c) hazardous materials data bases
(d) technical information centers (CHEMTREC, National Response Center)
(e) technical information specialists
(f) monitoring equipment
(g) NIOSH pocket guide to chemical hazards

2-D the importance of documentation for a hazardous materials incident including training records, exposure records, incident reports, and critique reports;

3-D how to keep an activity log and exposure records for a hazardous materials incident;

4-D the activities required in terminating the emergency phase of a hazardous materials incident;

5-D the considerations associated with conducting a critique of a hazardous materials incident;

6-D how to do the preparation of a locally required report with supporting documentation as necessary;

**E - LABORATORY SKILLS**

The Hazardous Materials Technician will be capable of the following "laboratory" tasks regarding radioactives, flammables, heavy metals, asbestos, acids and bases, and synthetic organic chemicals. Each task may be performed differently depending upon the type of material present.

**Tasks**:

E-1 Enter data
E-2 Analyze data
E-3 Manipulate data
E-4 Maintain quality assurance, quality control
E-5 Follow standard operating procedures for analyzing lab data
E-6 Calibrate, maintain, and operate equipment

The following knowledges should be taught or reviewed concurrently when teaching the above laboratory skills.

**Knowledges:**

1-E the general routes in which hazardous materials enter the human body upon exposure;

2-E the limitations of street clothes or work clothes at the scene of a hazardous materials incident;

3-E how to use the six groups of clues to detect the presence of hazardous materials;
4-E monitoring equipment used to monitor and detect the following hazards:

(a) toxicity
(b) flammability
(c) reactivity
(d) radioactivity
(e) corrosivity
(f) oxygen deficiency

5-E the purpose, operation (including interpretation of results and operation, calibration checks), and limitations for the following basic monitoring equipment, in addition to any other monitoring equipment provided to the hazardous waste technician by the authority having jurisdiction:

(a) combustible gas detector
(b) oxygen meter
(c) colorimetric tubes
(d) ph papers and strips
(e) CO meter
(f) radiation detection instruments
(g) OVA (Organic Vapor Analyzer)
(h) HNU (Photoionization Analyzer)
explosimeter

6-E the specific names of hazardous material involved in an emergency, or at least how to classify the material by its primary hazard using container markings, placards, pesticide labeling, shipping papers, Materials Safety Data Sheets (MSDS), or personal contacts;

7-E the source of, definition of, and circumstances for the use of the following terms:

(a) hazardous substances
(b) hazardous chemicals
(c) extremely hazardous substances
(d) hazardous wastes
(e) hazardous materials
(f) dangerous goods

8-E the advantages and disadvantages of each of the following information sources:

(a) MSDS
(b) reference guidebooks
(c) hazardous materials data bases
(d) technical information centers (CHEMTREC, National Response Center)
(e) technical information specialists
(f) monitoring equipment
(g) NIOSH pocket guide to chemical hazards

9-E the following chemical and physical properties and their importance in the risk management process:

(a) boiling point
(b) flammable (explosive) limits
(c) flash point
(d) ignition (autoignition) temperature
(e) specific gravity
(f) vapor density
(g) vapor pressure
(h) water solubility

10-E the following:

(a) Alpha Radiation
(b) Beta Radiation
(c) Gamma Radiation

11-E the following chemical and physical terms and their use in the risk assessment process:

(a) air reactivity
(b) catalysts and inhibitors
(c) concentration
(d) corrosivity
(e) critical temperature process
(f) instability
(g) oxidation ability
(h) ph
(i) polymerization
(j) radioactivity
(k) self-accelerating decomposition temperature (SADT)
(l) strength
(m) sublimation
(n) surface tension
(o) viscosity
(p) volatility
(q) water reactivity

12-E the following toxicological terms and their use in the risk temperature process:

(a) threshold limit value (TLV-TWA)
(b) lethal concentration and doses (LD 50/100)
(c) parts per million/billion (ppm/ppb)
(d) immediately dangerous to life and health (IDLH)

(e) permissible exposure limit (PEL)
(f) short-term exposure limit (TLV-STEL)
(g) ceiling fan (TLV-C)

13-E the following chemical and physical terms and their importance in the risk assessment process:

(a) compound mixture
(b) halogenated hydrocarbon
(c) ionic bond, covalent bond
(d) salt, nonsalt
(e) saturated, unsaturated, hydrocarbon, aromatics
(f) solution, slurry
(g) water miscible, immiscible

14-E the following toxicological terms and their importance in the risk assessment process:

(a) chemical interactions
(b) dose-response relationship
(c) effects: local, systemic
(d) exposure: acute, subacute, chronic
(e) routes of entry: ingestion, absorption, inhalation

15-E the following terms associated with chemical protective clothing:

(a) degradation
(b) penetration
(c) permeation

16-E how to interpret a chemical compatibility chart for chemical protective clothing, and the limitations and deficiencies of compatibility charts;

17-E the four levels of protection as found in the EPA/OSHA publications, the equipment required for each level, and the conditions under which each level is used;

18-E the basic decontamination procedures, as defined by the authority having jurisdiction, for victims, personnel, personal protective equipment, tools, equipment, and apparatus at a hazardous materials incident;

19-E the advantages and limitations of each of the following methods of decontamination.

(a) absorption
(b) adsorption
(c) chemical degradation
(d) dilution
(e) disposal
(f) isolation
(g) neutralization
(h) solidification

**F - SAFETY**

The Hazardous Materials Technician will be capable of the following "safety" tasks regarding flammables, radioactives, heavy metals, asbestos, acids and bases, and synthetic organic chemicals. Each task may be performed differently depending upon the type of material present.

**Tasks:**

F-01 Manage personal safety; 29 CFR 1910
F-02 Maintain site safety
F-03 Control and manage spills
F-04 Maintain industrial hygiene practices
F-05 Follow lab safety procedures
F-06 Develop site safety plan

The following knowledges should be taught or reviewed concurrently when teaching the above safety skills.

**Knowledges**:

1-F how hazardous material incidents are different from other "general" emergencies;

2-F the general routes in which hazardous materials enter the human body upon exposure;

3-F the limitations of street clothes or work clothes at the scene of a hazardous materials incident;

4-F the threats posed to property and the environment by hazardous materials releases;

5-F the precautions necessary when rendering emergency medical care to victims of hazardous materials exposure;

6-F the typical ignition sources found at the scene of a hazardous materials incident;

7-F the components of a site safety plan for a hazardous materials incident;

8-F the symptoms of heat stress;

9-F the local procedures for requesting additional resources dealing with a hazardous materials incident;

10-F the governmental and private sector agencies that offer assistance during a hazardous materials incident, including their role and the type of assistance or resources available;

11-F the purpose, need, and benefits of an Incident Command System at the scene of a hazardous materials incident;

12-F the process for implementing the Incident Command System for hazardous materials emergencies;

13-F the basic techniques used to deny site entry;

14-F the basic techniques used to isolate the immediate site;

15-F the basic techniques for evacuation in a hazardous materials incident;

16-F the functions and responsibilities of the hazard sector personnel within the Incident Command System.

Functions include:

(a) safety
(b) entry/reconnaissance
(c) information/research
(d) resources
(e) decontamination
(f) operations

17-F the nine hazardous materials classes, the primary hazards of each class;

18-F how to use the six groups of clues to detect the presence of hazardous materials;

19-F the typical locations in the community or facility where hazardous materials are manufactured, transported, stored, used, or disposed of;

20-F the placards, labels, container markings, and shipping papers used in the transportation of hazardous materials, and their advantages and limitations in recognizing hazardous materials;

21-F shipping papers found in various modes of transportation, the individuals responsible for the papers, and location where carried and found during an incident;

22-F the risk assessment consideration to be made at a hazardous materials incident:

(a) size and type of container and quantity involved
(b) nature of the container stress
(c) potential behavior of the container and its contents
(d) level of resources available (e.g., personal protective equipment, training, etc.)
(e) exposure potential to people, property, environment, and systems and
(f) weather conditions and terrain

23-F the various monitoring equipment used to monitor and detect the following hazards:

(a) toxicity
(b) flammability
(c) reactivity
(d) radioactivity
(e) corrosivity
(f) oxygen deficiency

24-F the purpose, operation (including interpretation of results and operation and calibration checks), and limitations for the following basic monitoring equipment, in addition to any other monitoring equipment provided to the hazardous waste technician by the authority having jurisdiction:

(a) combustible gas detector
(b) oxygen meter
(c) colorimetric tubes

(d) ph papers and strips
(e) CO meter
(f) radiation detection instruments
(g) OVA (Organic Vapor Analyzer)
(h) HNU (Photoionization Analyzer)
(i) explosimeter

25-F field maintenance and testing procedures, including operational and calibrations checks, for the basic monitoring provided to hazardous waste technician by the authority having jurisdiction;

26-F the specific names of hazardous material involved in an emergency, and/or how to classify the material by its primary hazard using container markings, placards, pesticide labeling, shipping papers, Material Safety Data Sheets (MSDS), or personal contacts;

27-F three sources of obtaining hazard response information about hazardous materials, the types of information about hazardous materials, and know the types of information provided in each;

28-F how to use the DOT Emergency Response Guidebook (ERG) in assessing hazards and response actions and determining isolation and evacuation distances;

29-F how to use a MSDS in obtaining hazard and response information and how to determine isolation and evacuation distances;

30-F the source of, definition of, and circumstances for the use of the following terms:

(a) hazardous substances
(b) hazardous chemicals
(c) extremely hazardous substances
(d) hazardous wastes
(e) hazardous materials
(f) dangerous goods

31-F the advantages and disadvantages of each of the following information sources:
(a) MSDS
(b) reference guidebooks
(c) hazardous materials data bases
(d) technical information centers (CHEMTREC, National Response Center)

(e) technical information specialists
(f) monitoring equipment
(g) NIOSH pocket guide to chemical hazards

32-F the analysis procedure for identification of unknown hazardous materials;

33-F the following chemical and physical properties and their importance in the risk management process:

(a) boiling point
(b) flammable (explosive) limits
(c) flash point
(d) ignition (autoignition) temperature
(e) specific gravity
(f) vapor density
(g) vapor pressure
(h) water solubility

34-F the following chemical and physical terms and their use in the risk assessment process:
(a) air reactivity
(b) catalysts and inhibitors
(c) concentration
(d) corrosivity
(e) critical temperature and pressure
(f) instability
(g) oxidation ability
(h) ph
(i) polymerization
(j) radioactivity
(k) self-accelerating decomposition temperature (SADT)
(l) strength
(m) sublimation
(n) surface tension
(o) viscosity
(p) volatility
(q) water reactivity

35-F the following toxicological terms and their use in the risk temperature process:

(a) threshold limit value (TLV-TWA)
(b) lethal concentration and doses (LD 50/100)
(c) parts per million/billion (ppm/ppb)

(d) immediately dangerous to life and health (IDLH)
(e) permissible exposure limit (PEL)
(f) short-term exposure limit (TLV-STEL)
(g) ceiling level (TLV-C)

36-F the respiratory hazards encountered at a hazardous materials incident, and the need for proper protective breathing apparatus, as prescribed by OSHA;

37-F the limitations of personnel working with protective breathing apparatus;

38-F the types of protective breathing apparatus and the advantages and limitations of each at a hazardous materials incident;

39-F the procedure for cleaning and sanitizing protective breathing apparatus for future use;

40-F the operational components of the types of protective breathing apparatus provided by the authority having jurisdiction and their function;

41-F the application, use and limitations of the following levels of protective clothing used at a hazardous materials incident:

(a) structural fire fighting clothing
(b) chemical fire protective clothing (nonencapsulating and encapsulating)
(c) high temperature clothing

42-F the proper donning, doffing, and usage of all personal protective equipment provided by the authority having jurisdiction for use in normal response activities;

43-F the factors to be considered in selecting proper respiratory protection at a hazardous materials incident;

44-F how to select the appropriate personal protective equipment to be used in an incident;

45-F the following terms as associated with chemical protective clothing:

(a) degradation
(b) penetration
(c) permeation

46-F how to interpret a chemical compatibility chart for chemical protective clothing, and the limitations and deficiencies of compatibility charts;

47-F maintenance, inspection, and storage procedures for level B and C chemical protective clothing, in addition to any other specialized equipment provided by the authority having jurisdiction;

48-F the four levels of protection as found in the EPA/OSHA publications, the equipment required for each level, and the conditions under which each level is used;

49-F four conditions that indicate material degradation of chemical protective clothing after chemical contact;

50-F the basic design and construction of containers and bulk and nonbulk packaging used to store, process, or transport hazardous materials, which would include but not be limited to:

(a) bags
(b) bottles
(c) boxes
(d) cans
(e) cans
(f) carboys
(g) drums
(h) fixed tanks
(i) intermodal portable tanks
(j) piping
(k) tank cars
(l) tank trucks and trailers

51-F the methods and precautions for controlling releases from nonbulk and bulk packaging and containers of hazardous materials;

52-F the tools, maintenance and testing procedures for the tools, equipment, and materials provided to the hazardous waste technician by the authority having jurisdiction for the control of the hazardous materials releases;

53-F the need for decontamination procedures at a hazardous materials incidents;

54-F the ways that personnel, personal protective equipment, apparatus, tools, and equipment become contaminated, and the importance and limitations of decontamination procedures;

55-F the basic decontamination procedures, as defined by the authority having jurisdiction, for victims, personnel, personal protective equipment, tools, equipment, and apparatus at a hazardous materials incident;

56-F the advantages and limitations of each of the following methods of decontamination:

(a) absorption
(b) adsorption
(c) chemical degradation
(d) dilution
(e) disposal
(f) isolation
(g) neutralization
(h) solidification

57-F the considerations associated with the placement, location, and set up of a decontamination site;

58-F the sources of technical information for performing decontamination operations;

## CERTIFICATION

Upon completion of the Hazardous Materials Technician program, the technician should be certifiable and capable of obtaining the following endorsements:

* 40-hour hazardous waste site - OSHA 29CFR 1910.120
* 24-hour Hazardous Materials update
* 8-hour Emergency First Responder awareness level
* Monitoring Well Driller/Constructor certification (state requirement)
* Asbestos accreditation

1. Asbestos Inspector
2. Asbestos Management Planner
3. Asbestos Abatement Project Designer
4. Asbestos Abatement Contractor/Supervisor
5. Asbestos Abatement Worker

## LAWS, RULES AND REGULATIONS

A Hazardous Materials Technician must be knowledgeable of current federal and state legislation pertaining to waste management. At the present time (1990) those laws creating the most impact are as follows:

**FEDERAL LAWS**

**OSHA** - Occupational Safety and Health Act. Regulates hazards in the workplace, including worker exposure to hazardous substances.

**RCRA** - Resource Conservation and Recovery Act of 1976. Regulates generation, storage, transportation, treatment, and disposal of hazardous waste. (42 U.S.C. 6901 et seq.)

**CERCLA** - The Comprehensive Environmental Response, Compensation, and Liability Act; commonly known as "Superfund", this act was passed in 1980 and provides for the cleanup of inactive and abandoned hazardous waste sites. (42 U.S.C. 9601 et seq.)

**SARA** - The "Superfund Amendments and Reauthorization Act of 1986." Title III of SARA includes detailed provisions for community planning.

**TSCA** - Toxic Substances Control Act enacted by Congress in 1976; this act allows the EPA to obtain information on new and existing chemicals and mixtures and to control the manufacture, distribution, and use of such substances. A specific provision governing polychlorinated biphenyls (BCPs) is included. AHERA - Asbestos Hazard Emergency Response Act signed by President Reagan in 1986, this act enacted Title II of the Toxic Substances Control Act (TSCA).

**CWA - CLEAN WATER ACT** - This statute controls the quality of the nation's navigable waters. Especially relevant are Section 402, governing permits for the discharge of substances into the navigable waters of the United States, and Section 311, prohibiting the discharge of oil and about 300 designated hazardous substances "in such quantities as may be harmful" (Epstein, Brown and Pope, p. 184).

**CAA - CLEAN AIR ACT** - This act governs air quality in the United States. It authorizes the EPA to set standards for air quality and to regulate air pollutants. Section 112 of the act specifically concerns "hazardous" air pollutants under the "NESHAPS" regulations.

**MSHA** - Mine Safety and Health Act - Regulates health and safety hazards in the mining and processing of minerals, including hazardous chemicals.

**HMTA** - Hazardous Materials Transportation Act - Requires the Department of Transportation to regulate transport of hazardous materials.

**NEPA** - National Environmental Policy Act of 1969 - Requires an analysis of project impacts whenever major federal action is involved.

**FIFRA** - Federal Insecticide, Fungicide, and Rodenticide Act. This statute governs the manufacture, distribution, and use of pesticides. Pesticides must be registered with the EPA before distribution and ultimately must be labeled and used in an approved manner.

**SDWA** - Safe Drinking Water Act. This act administered by the EPA is intended to control the levels of contaminants and chemicals in public water systems and underground drinking water supplies.

**SPSA** - The Consumer Product Safety Act. Administered by the Consumer Product Safety Commission, this act allows the commission to set safety standards for consumer products. If standards adequate to protect the public cannot be devised, the commission may ban the product.

## STATE REGULATIONS, GUIDES AND RULES

**ARM - MONTANA HAZARDOUS WASTE ADMINISTRATIVE RULES**; Title 16, Chapter 44. This book includes "The Montana Hazardous Waste Program - How it Differs From the Federal," and Cross Reference Tables 1 and 2 providing referencing between the Montana hazardous waste rules and their federal regulatory counterparts in 40 CFR parts 260 through 270.

**HAZARDOUS WASTE MANAGEMENT GUIDE - ARM**, page 261.20 through 261.25A Subpart C - The Characteristics of Hazardous Waste.

**OCCUPATIONAL HEALTH RULES** - Health and Environmental Sciences Title 16, Chapter 42, Administrative Rules of Montana (ARM).

**HAZARDOUS WASTE MANAGEMENT RULES** - Title 16, Chapter 44, Administrative Rules of Montana (ARM).

**SURFACE WATER QUALITY RULES** - Title 16, Chapter 22, Administrative Rules of Montana.

**MONTANA ENVIRONMENTAL POLICY ACT** - Title 75, Montana Codes Annotated (MCA).

**ANTIQUITIES** - Title 22, Montana Codes Annotated (MCA)

**PESTICIDES** - Title 80, Montana Codes Annotated (MCA).

**MONTANA SOLID WASTE MANAGEMENT ACT** - Section 75-10-201 through 75-10-233.

**MONTANA STORAGE TANK RULES FOR TANK MANAGEMENT AND OPERATION** - Title 16, Chapter 45, Administrative Rules of Montana

**MONTANA HAZARDOUS WASTE AND UNDERGROUND STORAGE TANK ACT** - 75-10-401 through 75-10-451.

**USED OIL STATUS SHEET** - an information sheet explaining the present status regarding the storage and disposal of used oil.

**TECHNICAL SUMMARY REPORT, MONTANA WASTE MINIMIZATION PROJECT**, For Small Quantity Generators

**AMENDMENT OF RULES** - before the Department of Health and Environmental Sciences of the State of Montana, these rules are intended to adopt minor changes in Montana Laws in order to achieve parity with federal regulations regarding definitions of Hazardous Waste.

## EQUIPMENT LIST

A Hazardous Materials Technician should be able to operate the following equipment.

**Lab Equipment List**

Oven
- C-140G
- Muffle Furnace
- Volatility Furnace
- Ash Fusion Furnace
- Moisture Oven
- Organic Ultimate
- Incubator
- Drying Oven

Balance
- A-30
- H6T

Autoclave

Sulfur Analyzer

Bomb Colorimeter (1241)

Spectrophotometer
- Spectronic 100
- Turbidimeter
- 951
- Video 2200

Centrifuge

Shaker

Air Compressor

Emission Spectrophotometer (JY48)

Atomic Absorption

Microscope

Gas chromatograph-(5890)

Auto Analyzer
- SMAC II
- Boron #1
- Ammonia #2
- Phosphorus #3
- Phosphorus #4

Sampling Pumps
- BDI

**Field & Lab Equipment**

Conductivity
- Bridge (310A)

pH Meter 501

Polarized Light Microscope

Soil Sieves

Respirator
- half mask air-purifying
- full facepiece air-purifying
- powered air-purifying
- full facepiece supplied air

Chemical-resistant clothing

Chemical-resistant safetyboots/shoes

Hard hat

Two-way radio

Coveralls

Disposable boot covers

Face shield

Safety boots/shoes

Safety glasses or chemical splash goggles

**Field Equipment**

Gurley meter

Air sampling pumps

Geiger counter

Personal sampling devices

Combustionable gas indicator

Flame ionization detector (HNU)

Color metric tubes

Oxygen deficiency meter/oxygen detector

## BIBLIOGRAPHY


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